Phase 1 Report

PeroxyChem

Performance Test
PAA Storage & Feed System
M.C. Stiles WWTP

City of Memphis, TN

October 5, 2018

Executive Summary

The Phase 1 Performance Test of the VigorOx® WWT II PAA Storage and Feed System at the M.C. Stiles WWTP has been completed. The algorithm was adjusted to meet the performance requirements outlined in the agreement between PeroxyChem and the City of Memphis under the current disinfection tank configuration and wastewater characteristics and validated during the second part of Phase 1. The conditions during Phase 1 included influent *E.* coli concentrations approximately twice of those observed during the 2015 full-scale trial, with wastewater flows generally lower than those observed then.

Outcomes of Phase 1 demonstrate:

- The adjusted algorithm provided PAA dose control that adequately tracked changes in wastewater color, which is the primary dose-control parameter.
- The adjusted algorithm provided PAA dose control that adequately responded to changes in wastewater effluent flow rate.
- The controlled PAA dose concentration subsequently was shown to control effluent *E. coli* concentrations to below target maximum microbial concentration limits:
    - All measured *E. coli* concentrations at the effluent during the second part of Phase 1 were below 244 MPN / 100 mL, which is the target daily maximum concentration
    - The 10-day geomean *E* coli concentration was determined to be 31 MPN / 100 mL, which is below the target maximum 30-day geomean concentration of 76 MPN / 100 mL.
    - PAA was able to achieve 4 – 6 log-reductions in *E*. coli concentration with the modified dosing algorithm.

This report and the conclusions herein are accurate based on the data generated from the Phase 1 test.

Philip Block, PhD
Technical Director – Water Treatment

I. Introduction

In accordance with Schedule A, Section 3.4.B of the agreement between PeroxyChem and the City of Memphis, PeroxyChem conducted the Phase 1 Performance Test from September 13 to October 2, 2018.

Phase 1 testing is an investigation of PAA performance under the dosing algorithm developed during the 2015 full-scale trial and the adjustment to the algorithm parameters to meet conditions as they exist today.

Phase 1 testing was conducted in two parts. The first part was assessment and adjustment of the previously developed dosing algorithm. The second part of the test was validation of this algorithm to ensure adequate PAA concentrations are being delivered to meet target microbial reductions under the current WWTP conditions. This report is a summary of the results from the Phase 1 test.

II. Methodology

The test protocol was defined in the Phase 1 Performance Test Procedure submitted to the City on August 20, 2018. The disinfection treatment objectives were defined in Schedule A, Section 1.7 of the agreement between PeroxyChem and the City of Memphis.

Phase 1 Performance Testing included two main parts:

- Calibration of 2015 algorithm
  - The 2015 PAA control algorithm was tested without modification on 9/13 and 9/14
  - Tests at multiple PAA doses were conducted to re-calibrate the algorithm from 9/17 to 9/21
  - The algorithm parameters were adjusted on 9/24
- Validation of adjusted algorithm
  - Tested in auto mode to validate algorithm from 9/25 to 10/2.

III. Results

3.1 Influent Water Conditions

Figure 1 displays the *E.* coli concentrations in the wastewater at the entrance to the disinfection tank (influent). Note that concentrations listed as 2,420,000 MPN / 100 mL are actually in excess of this value, but due to the dilution factors used for enumeration, these values are listed as > 2,420,000 and the true concentrations are not known. The figure shows the partitioning of Phase 1 into the two parts of the investigation as noted above.

During Phase 1, influent *E. coli* concentrations ranged from 488,000 MPN / 100 mL to > 2,420,000 MPN / 100 ml. In comparison, during the full-scale trial validation, the *E. coli* concentration ranged from 215,000 MPN / 100 mL to 1,210,000 MPN / 100 mL.

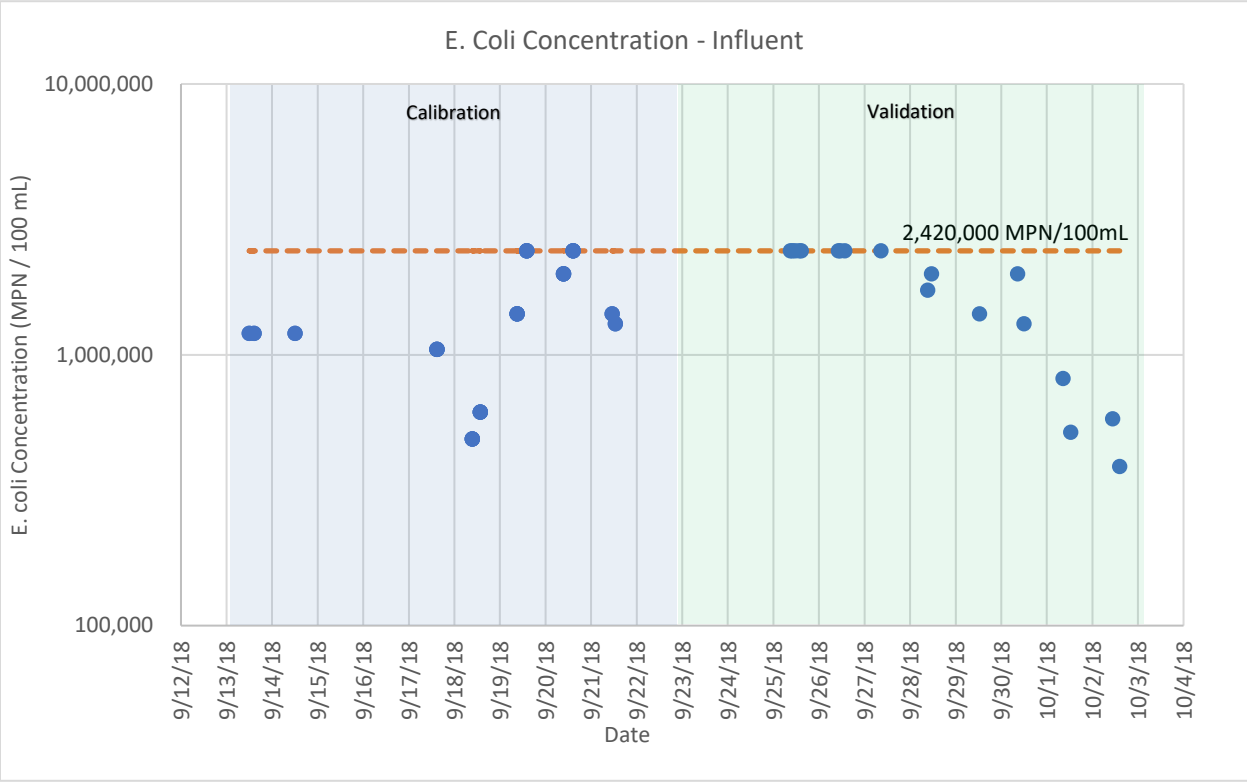

Figure 1. Influent E. Coli Concentrations

Figure 2 shows the influent wastewater color. The wastewater color varied between 323 and 1560 ptCo units, and it can be seen in the figure that the color went through one cycle during Phase 1. For comparison, during the field trial validation, color cycled through 700 and 3300 units.

Figure 3 displays the wastewater flow rate measured at each disinfection tank during Phase 1 trialing. During the first part of Phase 1, wastewater flow varied from 21 to 38 MGD, since both disinfection tanks were in service. For the second part of the trial, flow ranged from 29 to 125 MGD, primarily between 60 and 90 MGD since only the North disinfection tank was in service. During the 2015 trial, flow rate through the North disinfection tank varied from 80 to 135 MGD in comparison.

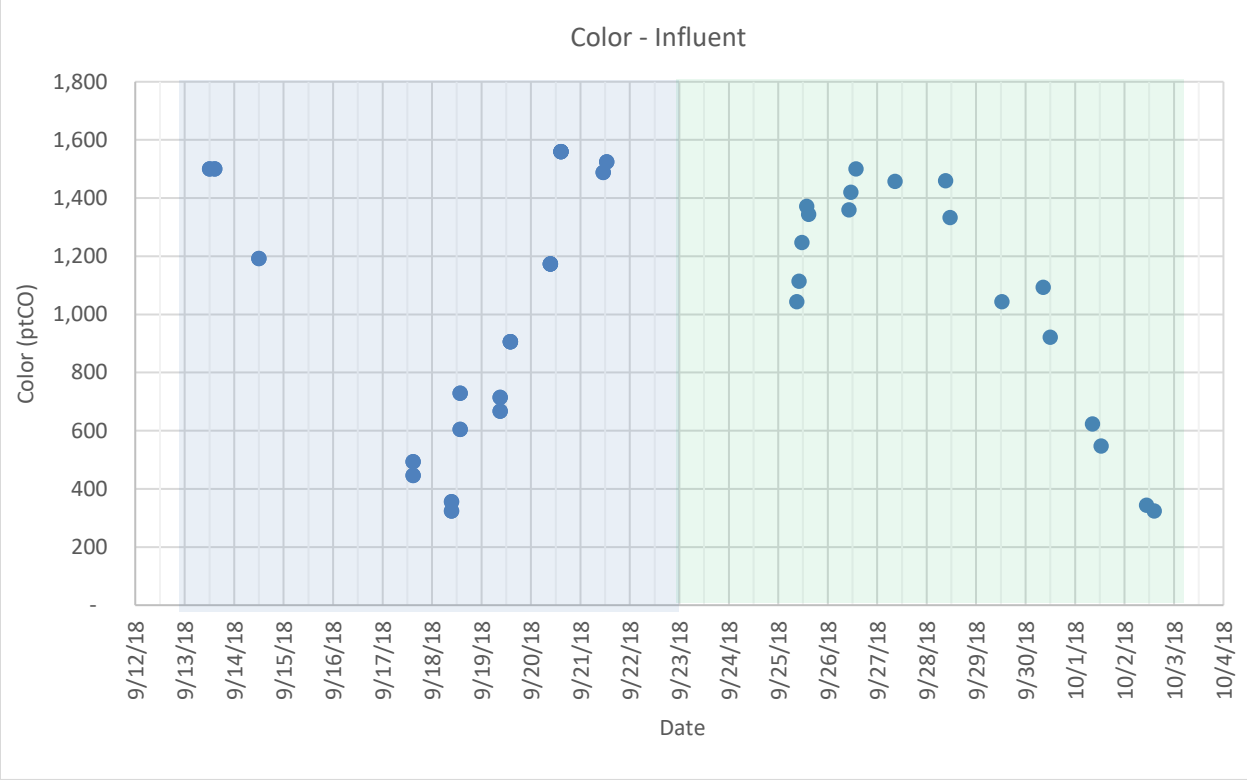

Figure 2 Influent Wastewater Color

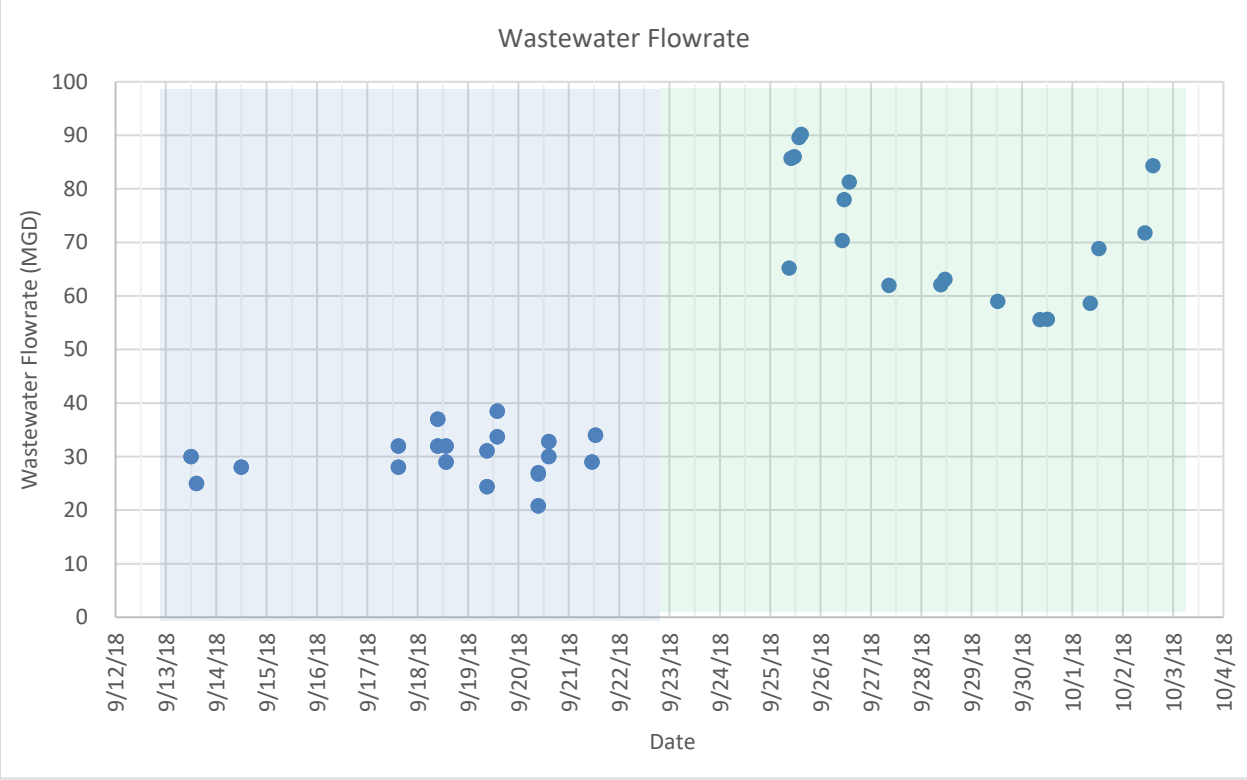

Figure 3 Plant Wastewater Flow Rate

3.2 PAA Concentration and Microbial Reduction

During the last phase of the 2015 trial, the base PAA dose concentration was set at 7 mg / L with additional PAA dose added based on color. During the first part of this Phase 1 demonstration, the PAA base dose and addition algorithm was tested. During the second part, the base dose was adjusted, and the addition algorithm tuned to meet the microbial reduction criteria with the current contact basin configuration and wastewater characteristics. The final algorithm utilizes a base dose of 9 mg / L. Figure 4 depicts the total PAA dose concentration added to the disinfection tank. The figure shows the different stages of Phase 1, with the last 7 days tracking with color.

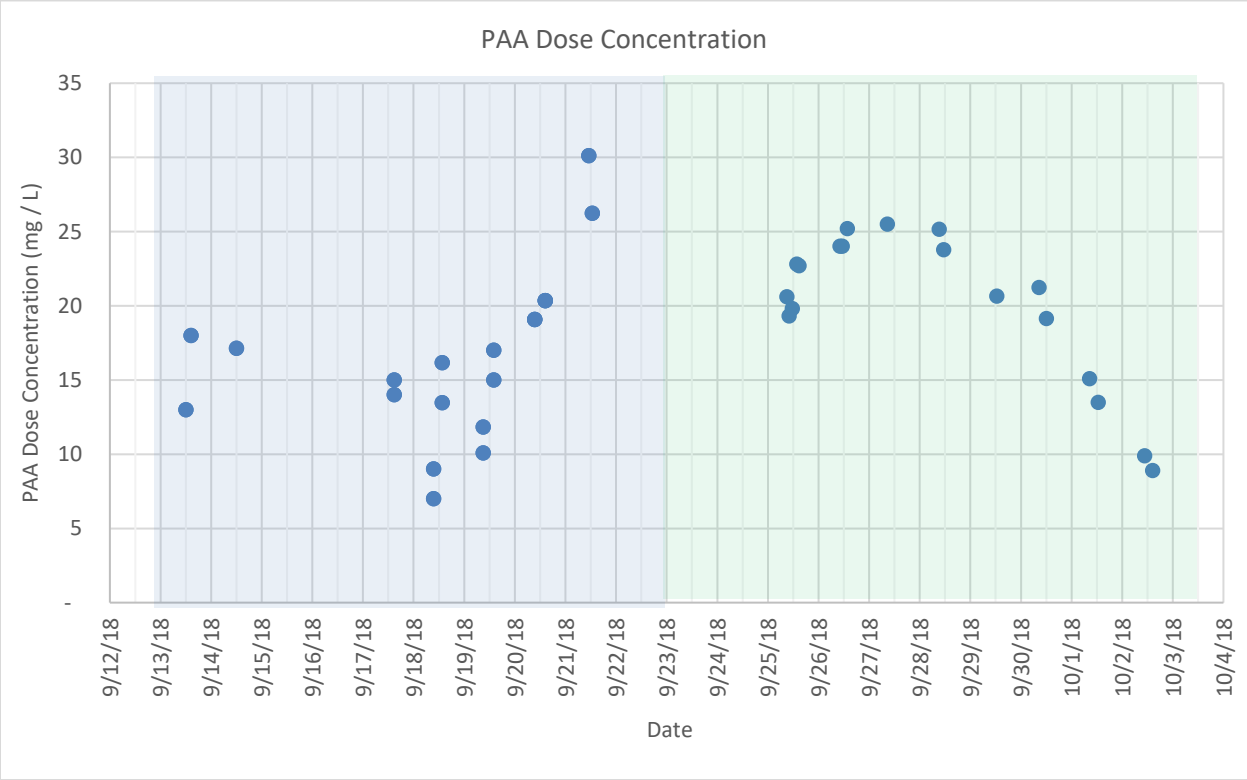

Figure 4 PAA Dose Concentration

Figure 5 graphs the PAA dose concentration and the wastewater color for the second part of Phase 1. From the figure, the dosing algorithm is shown to accurately track the PAA dose concentration with changes in wastewater influent color.

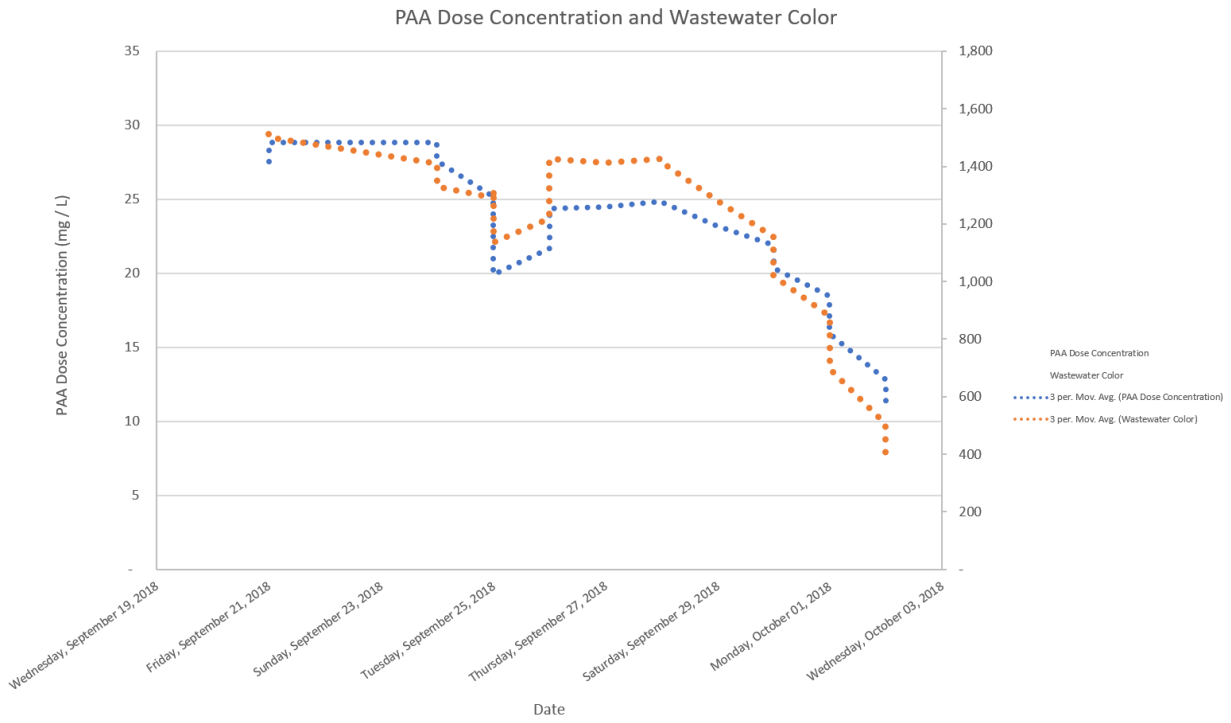

Figure 5 PAA Dose Concentration and Influent Wastewater Color

The resultant *E. coli* concentration at the weir of the disinfection tank is shown in Figure 6. Shown in the figure are the daily maximum *E. coli* concentration of 244 MPN / 100 mL and the monthly geomean maximum of 76 MPN / 100 mL. Table 1 relates the measured microbial concentrations at the outfall as compared to the target maximum levels for the second part of Phase 1 with the new PAA set dose and algorithm values. Note the geomean value is over a ten-day period, and not a full month geomean.

Target *E. coli Concentration*	Target Value	Measured Value
Daily maximum	< 244 MPN / 100 mL	0 measurements exceeded target value
Monthly geomean	76 MPN / 100 mL	31 MPN / 100 mL

Table 1: Microbial Reduction Performance for the Second Part of Phase 1

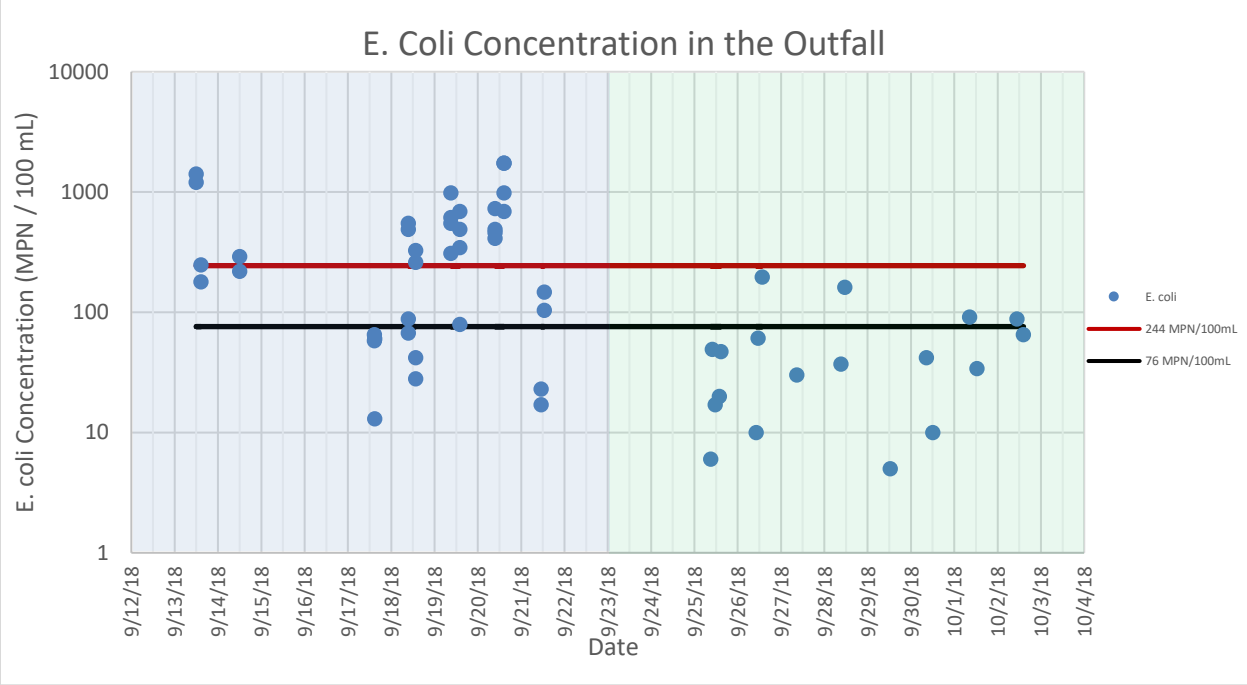

Figure 6. E coli Concentration at the Contact Chamber Outfall

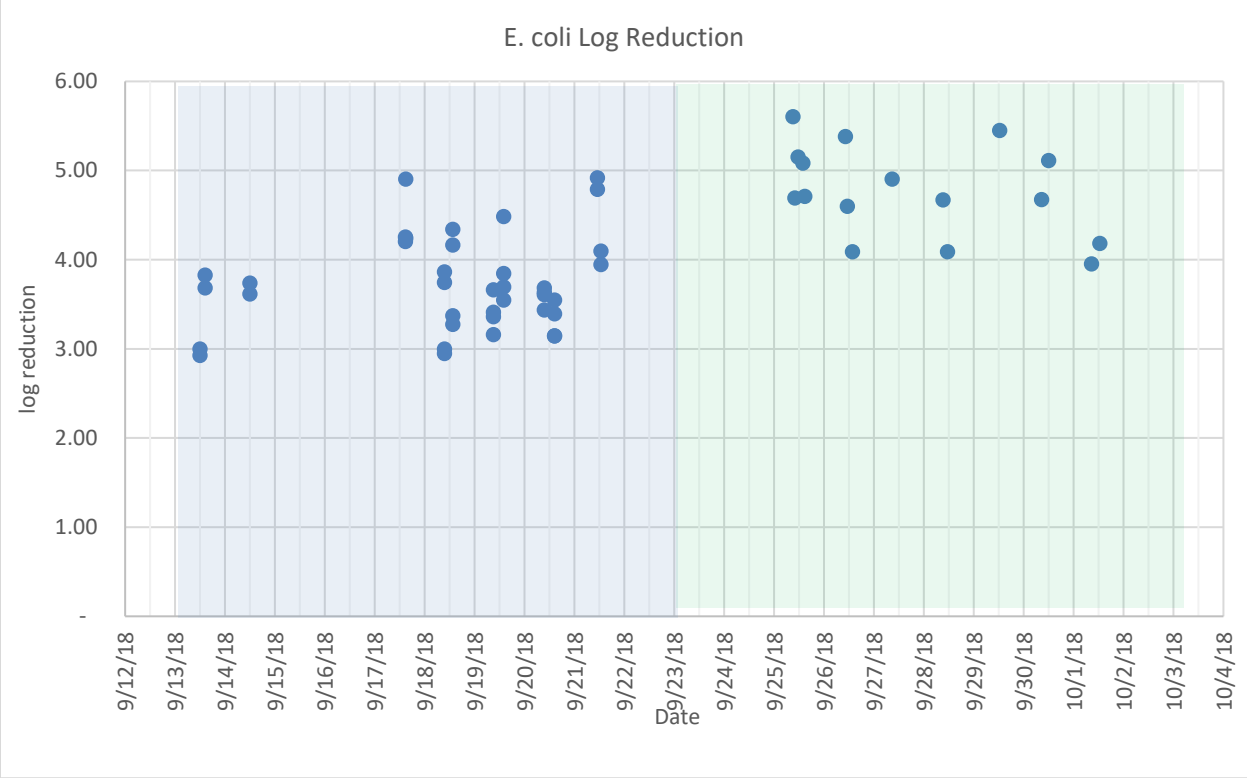

Figure 7. E. coli log reduction for Phase 1

Figure 7 displays the *E. coli* log reduction achieved during Phase 1.

During the second part of Phase 1, 4 to 6 log-reduction was achieved. Figure 8 shows the effluent *E. coli* concentration as a function of PAA residual measured at the outflow weir.

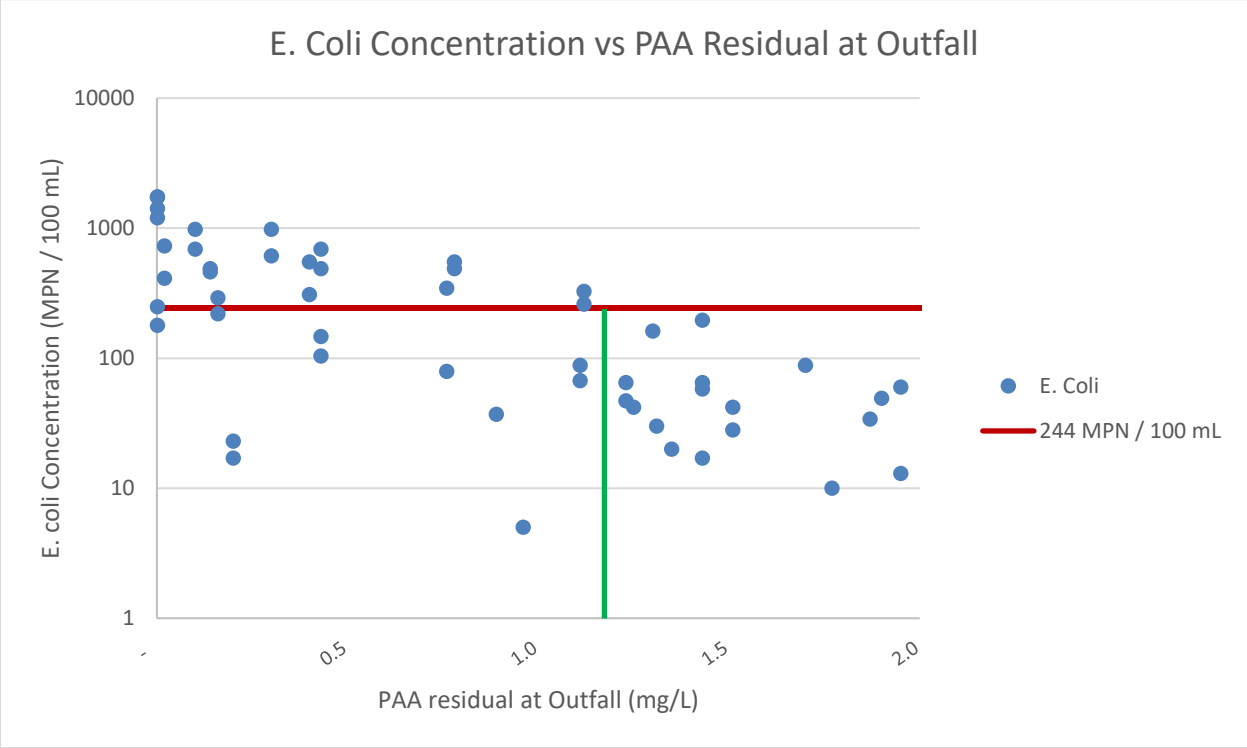

Figure 8. E. coli Effluent Concentration as a Function of PAA Residual Concentration

As shown, with a PAA residual greater than 1.2 mg / L, all measured *E. coli* concentrations were below the daily maximum of 244 MPN/ 100 mL. While several factors impact both the PAA residual and microbial reduction, including initial PAA dose, wastewater oxidant demand and contact time, within the parameters of these wastewater flows and color, targeting a PAA residual of 1 to 1.5 mg / L is a good indicator of disinfection performance.

IV. Conclusions

The Phase 1 Performance Testing of the VigorOx WWT II PAA Storage and Feed system at the M.C. Stiles WWTP has been completed. The first part of Phase 1 investigated the performance of the PAA dosing algorithm as developed during the 2015 full-scale demonstration trial. The algorithm was calibrated to meet the current needs of the baffled disinfection contact channel and wastewater characteristics and tested out during the second part of Phase 1. The conditions during Phase 1 included influent *E.* coli concentrations approximately twice that during the full-scale demonstration project, with wastewater flows generally lower than those previous tested under.

Outcomes of Phase 1 demonstrate:

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- The controlled PAA dose concentration subsequently was shown to control effluent *E. coli* concentrations to below target maximum microbial concentration limits
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